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Ultra-low-latency audio and video network transmissions

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- Ultra-low-latency audio and video network transmissions
- Transceiver + receiver latency from 0.9 ms for audio and video
- Configurable buffering to compensate network packet jitter
- Video - 3G-SDI interfaces, lightweight TV studio quality compression
- Audio - built-in 8-channel 24-bit / 48 kHz audio DAC/ADC, 2-channel S/PDIF, 4-channel SDI embedded audio
- Network - Gigabit Ethernet (streaming and management interfaces)



- Concerts and performances between cities and countries
- Playing together across distance
- Connecting non-portable instruments (organs, precious instruments)
- Unique experience for the audience
- Applications in distance collaboration and learning in various fields (industrial design, scientific visualizations, medical)



- High-quality network connection
- Low-latency audio and video network transmission
- Low-latency cameras and TVs / projectors
- Proper arrangement of local and remote sound capture and reproduction (volume, direction, reverberation, acoustic echo suppression)



Can I use videoconference software?

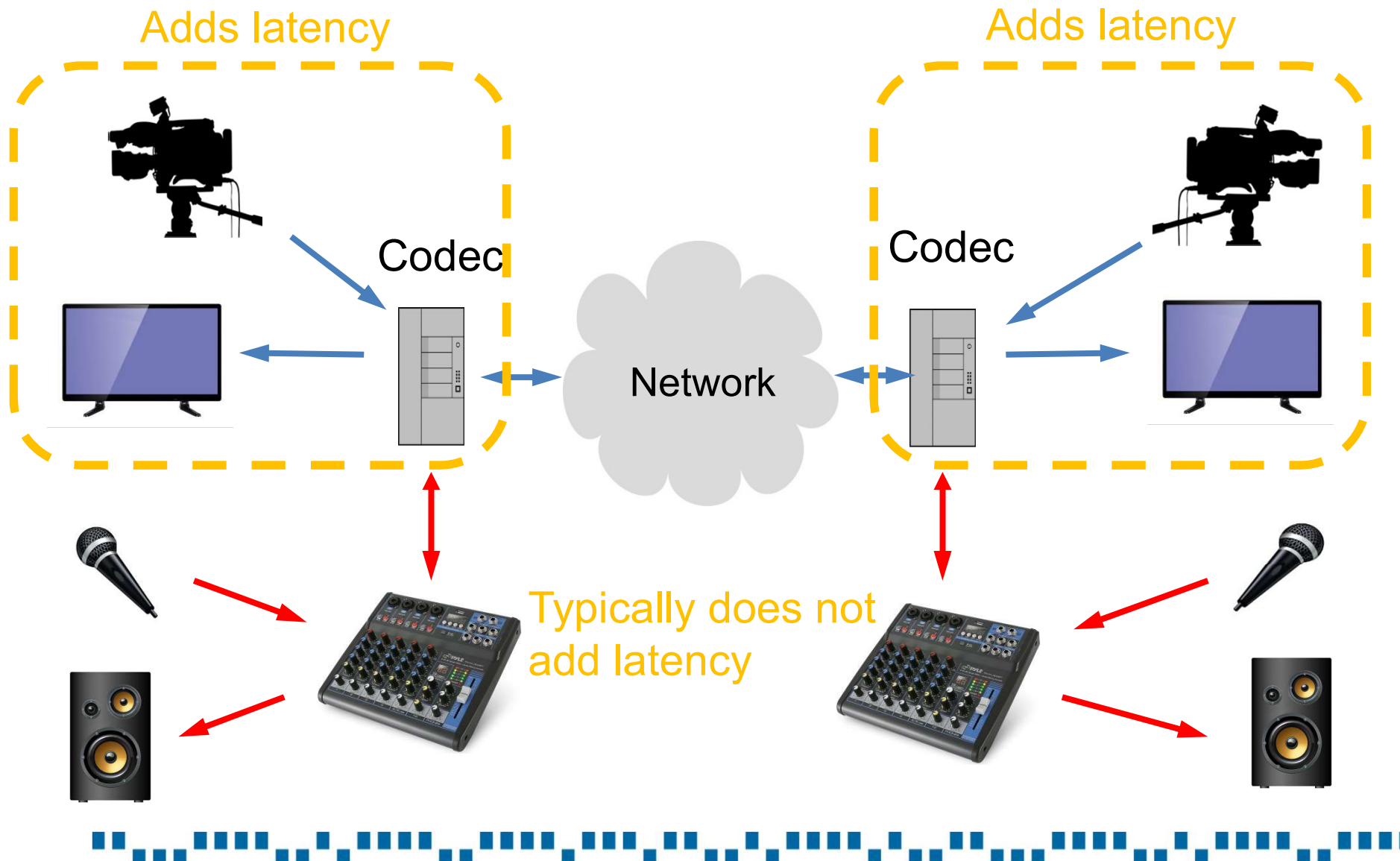
- Zoom, Cisco Webex, MS Teams, Skype, etc.
- Videoconference software uses high compression, strong digital echo suppression and may transmit over a distant cloud server
- Typical latency is over 150 ms, which prohibits playing together
- Video quality is not suitable for HDTV production
- Zoom provides the “original sound” mode, which improves sound quality (but latency remains high)





- Network propagation delay is limited by the speed of light and is close to 20 ms across Europe, which is the approx. limit for playing music together
- Consequence: the delay of audio and video equipment must fit into just a few milliseconds





- MVTP provides video and audio transmissions with ultra low added latency from SDI video and analog audio inputs on the transceiver to the SDI video and analog audio outputs on the receiver



Audio buffer set to 32 samples: transceiver to receiver latency 2.2 ms



Video buffer set to 20 packets: transceiver to receiver latency 1.06 ms



- Many video cameras add latency of 1-3 frames between the scene and the output signal, which equals approx. 16-100 ms
- Audio connected to a camera will also be delayed, unless the camera can be set to a „live mode“
- Low-latency cameras exist, for example:
 - Dream Chip Technologies Atom One – approx. 2 ms
 - Blackmagic URSA mini family and Blackmagic Micro Studio – approx. 4 ms

S. Ubik, J. Pospisilik, Video Camera Latency Analysis and Measurement, IEEE Transactions on Systems and Circuits for Video Technology, Vol. 31, No. 1, Jan. 2021, pp. 140-147



- Most current PC monitors have very low latency < 2 ms
- TV sets need to be switched to a „game mode“
- Projector latency is typically tens of ms (60-100 ms)
- Consequence: use a separate monitor / TV for musicians



- Latency and bandwidth are tradeoff – finding more redundancy to reduce bandwidth implies buffering more data
- A few milliseconds latency requires little buffering and high bandwidth – approx. 200 Mbps for 1080p30 and 400 Mbps for 1080p60
- Two preferable technologies for the network connection are fiber optics and microwave connections



Example events made possible with the MVTP
technology for ultra-low-latency audiovisual
transmissions





- Concert „A Tribute to the Brave“ in the award ceremony of the Vaclav Havel Prize for Human Rights in 2018, connecting the cities of Prague and Bratislava
- Prague: the church of St. Anne, Petr Nouzovský (violoncello) + audience
- Bratislava: the hall of the Academy of Performing Arts (VŠMU)
- Recording: <https://youtu.be/f0mfY7ZKtmk?t=934>



- Organs cannot be moved and can only be connected remotely, which brings new possibilities to musicians and a unique experience for the audience
- 1st organ: Church of the assumption of the Virgin Mary in Brno, Czechia
- 2nd organ: University in Trondheim, Norway
- Sample recording: <https://www.youtube.com/watch?v=tQOb7ZoJ91k>



- A performance between four churches - an organ, a vocal and three bells, February 2019
- The performance commemorated the 70th anniversary of the death of Josef Toufar, a catholic priest tortured to the death by the Communist secret police.
- Author of the project: Otakar Dušek
- Musicians: Jaroslav Tůma – organ
Michaela Gemrotová – vocal
Groove Army – bells



- Musicians were playing together at the Prague Clarinet Days festival and at the Internationale Sommerakademie in Vienna in August 2020
- Locations: the Academy of Performing Arts in Prague and the University of Music and Performing Arts in Vienna
- Recording: <https://youtu.be/sHV9YleIBg8>



- Ancerlovo String quartet in Prague and Bogdan Nikola (piano) in Copenhagen
- Prague: the Senate building of the Czech Parliament
- Copenhagen: The Royal Danish Academy of Music
- Music: Antonín Dvořák, kvintet no. 2 in A major, Opus 81, 1st and 3rd movements



Sample video: <https://www.youtube.com/watch?v=-gz7N5rG6CE>



- Performance „I wish I dance well under the stars“ inspired by the book of Marek Orko Vácha, April 2019
- Organs in churches of the St. Lawrence, St. Simon and Judas and in the Martinu Hall of the Academy of Performing Arts in Prague
- Dance in Prague and Barcelona with a holographic projection
- 10 cameras, 3 live edits for audience and Internet streaming



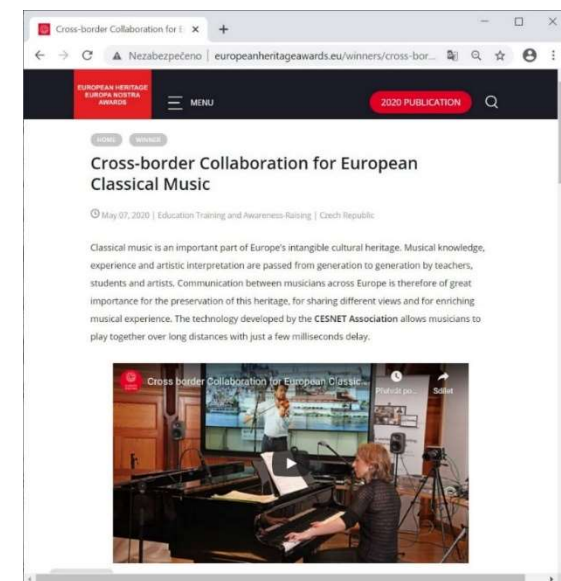
- Real-time performance between 4 countries, 3 continents
- The Unlimited Trio (violin, guitar, accordion) in Prague
- Dancers in Barcelona, Salvador (Brasil) and Daejeon (Korea)
- Sample recording: <https://www.youtube.com/watch?v=H4CHDYGvuvo>



- Real-time performance „Similarities“ between 4 countries, 2 continents
- Artistic Director & Choreography: Jana Bitterová
- The Unlimited Trio (violin, guitar, accordion) in Prague (Nat. Tech. Library)
- Dancers in Copenhagen (The Royal Danish Academy of Music),
Barcelona (Konic Theatre), Miami (The New World Symphony)
- Sample recording: <https://www.youtube.com/watch?v=u96xoCPOQ04>



- The MVTP technology and its real world use received the European Heritage Award / Europa Nostra Award 2020 for the contribution to collaboration in classical music in an European scale



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